EXHIBIT 2

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF FLORIDA

ADVANCED GROUND INFORMATION SYSTEMS, INC., Plaintiff. v. LIFE360, INC., Defendant.	**Case No. 9:14-cv-80651-DMM**

DECLARATION OF DR. BENJAMIN GOLDBERG IN SUPPORT OF PLAINTIFF ADVANCED GROUND INFORMATION SYSTEMS, INC.'S OPENING CLAIM CONSTRUCTION BRIEF

I, Dr. Benjamin F. Goldberg, hereby declare and state as follows:

I. Introduction

1. I am submitting this declaration on behalf of Advanced Ground Information Systems, Inc. ("AGIS") in the litigation identified on the foregoing page. I understand that AGIS has accused Life360 of infringing certain claims in AGIS's United States Patent Nos. 7,031,728 ("the '728 patent"), 7,672,681 ("the '681 patent"), 7,764,954 ("the '954 patent"), and 8,126,441("the '441 patent" and, collectively, "the Patents-in-Suit").

2. I have been asked to consider how one of ordinary skill in the art to which the Patents-in-Suit are directed would have understood (at the time of invention) various terms in the claims of the Patents-in-Suit. Specifically, I have been asked to opine on the meaning of the following claim terms: "symbol generator," "CPU software for selectively polling other participants," "soft switch," "soft switch matrix," "CPU software that causes the exchange of data with other participants with a cellular phone, " "private . . . network," "peer to peer network," "SMS polling message," and "establishing, over a private remote server excluding a website or a web browser, a communications network." This declaration summarizes my opinions regarding those meanings.

3. I understand that further expert discovery will occur at a later stage in this case, including the submission of expert reports on the infringement and validity of the Patents-in-Suit. I reserve my right to update my opinions in this declaration regarding the meaning of the claims of the Patents-in-Suit through any further expert reports and/or testimony that I may provide in this case.

II. Background, Qualifications, and Compensation

4. I am a citizen of the United States of America residing in New York, New York. I am currently a tenured associate professor in the Department of Computer Science at New York University. I have attached a copy of my curriculum vitae as Exhibit 1.

5. I have authored or co-authored numerous publications over the past ten years. A listing of these publications is attached to my CV.

6. I am being compensated at a rate of $450 per hour for time spent on this matter. My compensation is not related in any way to the outcome of this action.

III. Legal Standards

7. I understand that the terms in a patent claim are given the ordinary and customary meaning that they would have had to a person of ordinary skill in the art at the time the patent was filed.

8. I understand that the usual and customary meaning of a claim term can be altered by the patent applicant if he chooses to act as his own "lexicographer" and clearly sets forth in the patent a different meaning for a claim term.

9. I understand that the meaning of a claim term can also be altered during the patent examination process by statements the patent applicant makes about the meaning or scope of the term, and that such statements are recorded in the prosecution history of the application.

10. I understand that if a claim term is ambiguous or unclear, the term must be construed to determine how a person of ordinary skill in the art would have resolved the ambiguity in light of the rest of the patent specification, claims and application file history. I further understand that this hypothetical person of ordinary skill in the art is considered to have the normal skills of a person in a certain technical field. I understand that factors that may be considered in determining the level of ordinary skill in the art include: (1) the education level of

the inventor; (2) the types of problems encountered in the art; (3) the prior art solutions to those problems; (4) rapidity with which innovations in this art are made; (5) the sophistication of the technology; and (6) the education level of active workers in the field.

IV. Materials Considered

11. I have considered the following materials in preparing the opinions set forth in this declaration: (a) the Patents-in-Suit, including the specifications and claims; (b) the prosecution histories of the Patents-in-Suit in the United States Patent & Trademark Office ("the PTO"); (c) the Revised Joint Claim Construction Statement and Exhibit A to the Revised Joint Claim Construction Statement submitted by the parties in this case (D.I. 45) including the extrinsic evidence cited therein; and (e) any documents cited in this declaration. I also relied on my own training and experience as a computer scientist in the field to which the Patents-in-Suit are directed, along with my understanding of how one of ordinary skill in the art would have understood the disclosure of the Patents-in-Suit.

V. The Level of Skill in the Art to Which the Patents-in-Suit Pertain

12. It is my understanding that I must address the issues set forth in this declaration from the viewpoint of a person of ordinary skill in the art to which the patents-in-suit pertain.

13. In my opinion, one of ordinary skill in the art to which the Patents-in-Suit pertain would have had at least a bachelor's degree in computer science or a related field and one year of work experience in programming (or equivalent on-the-job training).

VI. The Patents-in-suit

14. I understand that AGIS has alleged infringement by Life360 of claims 3, 7, and 10 of the '728 patent, claims 1, 5, and 9 of the '681 patent, claims 1 and 2 of the '954 patent, and claims 1-8 of the '441 patent.

15. I have read and reviewed the'728 patent and its prosecution history. I understand that the other three asserted patents claim priority to the '728 patent. The '728 patent describes mobile devices and communications networks thereof. These mobile devices each have a touch display screen that depicts the location and status of other participants in a communication network on a map. *See, e.g.,* '728 patent, 11:10-42. A participant in the communication network may communicate with others in the network by touching symbols representative of the other participants on a map displayed on the screen of the mobile device. *Id.* The mobile devices are able to communicate via, for example, telephone calls, send a text messages, data or a pictures. *Id*. Additionally, the mobile devices may be able to obtain the location of other devices by, for example, polling the other participants. *See, e.g., id.* at 6:13-28; 10:46-51.

16. I have read and reviewed the '681 patent and its prosecution history. I understand that the '681 patent adds to the ideas of the '728 patent, and describes systems and methods for changing the symbols and soft switches on the touch screens of the mobile devices in a communications network by, for example, utilizing "administrator software." *See, e.g.,* '681 patent, 9:60-11:56.

17. I have read and reviewed the'954 patent and its prosecution history. I understand that the '954 patent adds to the ideas of the '728 patent, and describes methods of increasing the efficiency of the communications network and the corresponding mobile hardware. For example, in one embodiment, the '954 patent describes a method wherein a participant's mobile device retrieves additional maps from a server, where those maps were not stored on the mobile device, so as to save space. *See, e.g.,* '954 patent, 7:30-64. In another embodiment, the '954 patent discloses a method for conserving display space by reducing the number of soft switches that are visible on a display area, so as to maximize the viewable map area. *See, e.g., id.* at 10:56-11:16.

18. I have read and reviewed the '441 patent and its prosecution history. I understand that the '441 patent adds to the ideas of the '728 patent, and describes new methods for "polling" in a communications network. For example, one embodiment of the '441 patent describes a "polling" method wherein a first participant sends a polling message to a second participant that causes the second participant's information, such as his location, to be reported to other participants in the communications network. *See, e.g.,* '441 patent, 8:29-63. The '441 patent describes additional embodiments wherein the communications network includes various groups, such as a common interest network of family and friends. *See, e.g., id.* at 9:19-58.

VII. The Meaning of the Claim Terms of the Patents-in-Suit

19. I reviewed the parties' Revised Joint Claim Construction Statement in connection with the preparation of this declaration. Based on my review of that statement, as well as my independent review of the Patents-in-Suit, their prosecution histories and the other materials referenced in this declaration, along with my own experience and expertise, I agree with the claim meanings proposed by AGIS in the Revised Joint Claim Construction Statement and do not agree with the meanings proposed by Life360. I also understand that, at the same time that I am submitting this declaration, Life360 will submit a paper further explaining its positions on the meaning of these disputed claim terms, and I therefore reserve my right to take into account, and to address, Life360's positions at that time.

1. "symbol generator"

AGIS's Proposed Construction	Ordinary English meaning, no construction necessary Does not implicate 35 U.S.C. § 112(6)/112(f)
Life360's Proposed Construction	Invokes 35 U.S.C. § 112(6) and is indefinite. Structure: An undisclosed algorithm or software function Function: generate symbols that represent each of the participants' cell phones in the communication network on the display screen ('728 Patent, claim 3; '681 Patent, claim 5); generate symbols on said touch display screen ('728 Patent,

	claim 10; '681 Patent, claim 9)
Claims	'728 patent, claims 3, 10; '681 patent, claims 5, 9

20. I understand that the term "symbol generator" appears in claims 3 and 10 of the '728 patent and in claims 5 and 9 of the '681 patent. I have reviewed the specifications and prosecution histories of the '728 and '681 patents, and I agree that the term "symbol generator" in these patents should be given its ordinary English meaning.

21. Furthermore, one of ordinary skill in the art would have understood that a symbol generator is a standard module of software code that was well known in the art and that the term "symbol generator" would have been sufficient to identify these modules of program code to one of ordinary skill in the art. One of ordinary skill in the art would have understood that there existed classes of software subroutines that programmers would have known to use to generate symbols on a display. For example, one of ordinary skill in the art would have known how to utilize common graphics libraries along with corresponding application programming interfaces ("APIs") to generate images on a display.

22. I also note that at least one embodiment in the specifications of the '728 and '681 patents includes an algorithm for generating symbols on a display. As expressed in the '728 patent, this algorithm is executed on a CPU that (1) "coordinates the x and y coordinates on the LCD display touch screen with the geographical display" and (2) places symbols on the geographical display that represents other cellular phone users that are part of the communications net. *See, e.g.*, '728 patent, 10:40-46; *see* also '681 patent, 7:14-19. Utilizing these steps, the symbol generator renders symbols on the display screen that represent other

participants. Utilizing the above mentioned libraries and APIs, one of ordinary skill in the art would have been able to implement the above-described algorithm.

2. "CPU software for selectively polling other participants"

AGIS's Proposed Construction	No separate construction necessary (*see* "selectively polling other participants" above) Does not implicate 35 U.S.C. § 112(6)/112(f)
Life360's Proposed Construction	Invokes 35 U.S.C. § 112(6) and is indefinite. Structure: An undisclosed algorithm or software function residing in the CPU of the cellular phone Function: selectively polls other participants [*see* "selectively polling other participants" above]
Claims	'728 patent, claim 10

23. I understand that the term "CPU software for selectively polling other participants" appears in claim 10 of the '728 patent. I also understand that the parties have agreed to construction of the term "selectively polling other participants" as "selectively sending a command to the cellular phones of other participants whose cellular phones respond."

24. It is my opinion that one of ordinary skill in the art would have understood "CPU software for [selectively sending a command to the cellular phones of other participants whose cellular phones respond]" to be a standard module of software code that was well known in the art. One of ordinary skill in the art would have understood that there existed classes of software subroutines that programmers would have used to selectively send a command to the cellular phones of other participants whose cellular phones respond. For example, one of ordinary skill in the art would have known how to utilize common networking and user interface libraries along with corresponding APIs to select a user via a user interface, such as a touch screen, and then to send that user's cellphone a polling message via a known networking interface.

25. Furthermore, it is my opinion that the term "CPU software" would have been sufficient to identify these modules of program code to one of ordinary skill in the art.

26. I also note that the specification of the '728 patent includes an algorithm for accomplishing selecting and polling:

> "To initialize the communications net, the cellular phone one operator selects, from a list, the other users (or all of them), that the operator desires to be part of the communications net. The system then polls the selected phones to activate and become part of the communications net. The selected phones then transmit their positions to all the other phones in the established net."

'728 patent, 4:39-46. One of ordinary skill in the art would have understood that this embodiment utilized CPU software to detect that the participant selected a polling operation and initiated a polling request to one or more devices over the communication network. One of ordinary skill in the art would have understood that these algorithmic steps define how the CPU software selectively achieves polling.

27. It is my opinion that one of ordinary skill in the art would have been able to implement the disclosed algorithm using known modules of networking and user interface code.

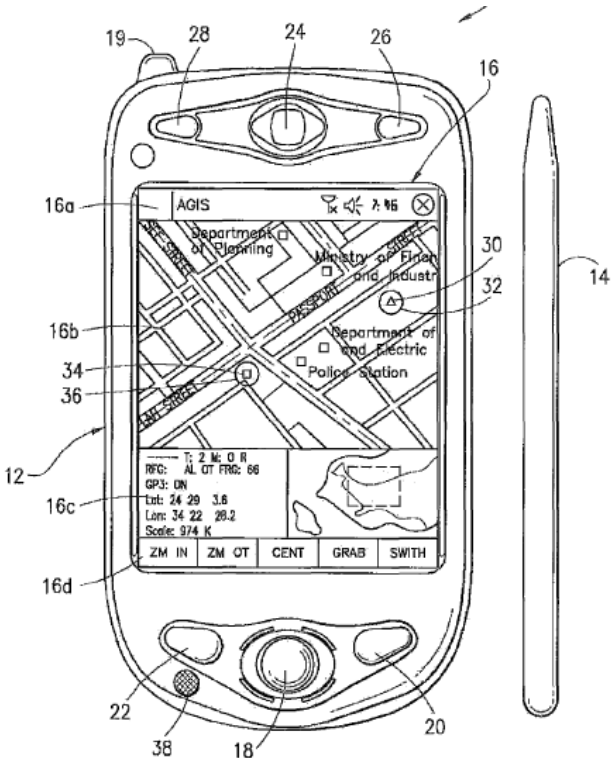
3. "soft switch"

AGIS's Proposed Construction	"a temporary or changeable switch"
Life360's Proposed Construction	"A virtually displayed switch on a touch screen that, when activated, performs a function." A soft switch associated with a symbol is different than the symbol itself.
Claims	'681 patent, claims 1, 5, 9; '954 patent, claims 1, 2

28. I understand that the term "soft switch" appears in claims 1 and 2 of the '954 patent and in claims 1, 5, and 9 of the '681 patent. I have reviewed the specifications and

prosecution histories of the ’954 and ’681 patents and I agree that, in the context of the claims read in light of the specifications, the term “soft switch” means “a temporary or changeable switch.” One of ordinary skill in the art would have understood that the term “soft” in the context of computer science means “temporary or changeable”, as is to be expected when something is implemented in software. *See, e.g.*, COMPUTER DICTIONARY 365 (2d ed. 1994) (defining the prefix “soft” in the computing context as “an adjective meaning temporary or changeable”).

29. Furthermore, one of ordinary skill in the art would have understood that the soft switch of the ’954 and ’681 patents is defined by its function or action, as well as by its location on the display screen. *See, e.g.*, ’681 patent, 2:22-46, 5:55-56, 9:29-42; ’954 patent, 5:19-21, 8:50-64, 10:9-25. This switch may be represented by text or graphics including, for example, a symbol. As depicted in Figure 1 of the ’682 patent, a participant may touch a soft switch defined by the symbol representative of the other participant (30, 34).



’681 patent, Fig. 1.

4. “soft switch matrix”

AGIS’s Proposed Construction	No separate construction necessary (*see* “soft switch” above) Ordinary English meaning, no construction necessary
Life360’s Proposed Construction	“a collection of soft switches presented in a series of rows and columns”
Claims	’954 patent, claim 2

30. I understand that the term “soft switch matrix” appears in only one asserted claim: claim 2 of the ’954 patent. I understand that Life360 seeks to construe the term “matrix” so as to exclude a single column or single row matrix. As I described above, I have reviewed the ’954 patent as well as its prosecution history. I did not find any reason to limit the term “matrix” to a meaning different from its ordinary English meaning.

31. One of ordinary skill in the art would have known that the plain meaning of “matrix” includes either a matrix having a single row or a matrix having a single column. For example, elementary Linear Algebra texts describe matrices as having a “size m × n” wherein “[m]atrices of a single row or a single column are often called row vectors or column vectors, respectively.” (Meyer 2000 at 8).

5. “CPU software that causes the exchange of data with other participants with a cellular phone”

AGIS’s Proposed Construction	Ordinary English meaning, no construction necessary Does not implicate 35 U.S.C. § 112(6)/112(f)
Life360’s Proposed Construction	Invokes 35 U.S.C. § 112(6) and is indefinite. Structure: An undisclosed algorithm or software function residing in the CPU of the cellular phone Function: causes the exchange of data with other participants with a cellular

	phone
Claims	’681 patent, claim 9

32. I understand that the term “CPU software that causes the exchange of data with other participants with a cellular phone” appears in claim 9 of the ’681 patent. I have reviewed the specification and prosecution history of the ’681 patent, and I agree with AGIS that this term should be construed according to its ordinary English meaning.

33. It is my opinion that one of ordinary skill in the art would have understood “CPU software that causes the exchange of data with other participants with a cellular phone” to be a standard module of software code that was well known in the art. One of ordinary skill in the art would have understood that there existed classes of software routines that programmers would have used to electively send data to the cellular phones of other participants whose cellular phones respond. For example, one of ordinary skill in the art would have known how to utilize common networking libraries along with corresponding APIs to cause the exchange of data with other users. For example, one of ordinary skill in the art would have known how to utilize these protocols and APIs to construct data packets such as TCP and/or UDP packets, address them to other network users, and send them over a network.

34. Furthermore, it is my opinion that the term “CPU software” would have been sufficient to identify these modules of program code to one of ordinary skill in the art.

35. I also note that the specification of the ’681 patent includes an algorithm for accomplishing the exchange of data:

> Conventional PDA/cellular phones are currently on sale and sold as a unit (or with an external connected GPS) that can be used for cellular telephone calls and sending cellular SMS and TCP/IP or other messages using the PDA's display 16 and computer (CPU). The GPS system including a receiver in housing 12 is capable of determining the latitude and longitude and, through SMS, TCP/IP, WiFi or other digital messaging software, to also transmit this latitude and longitude information of housing 12 to other cellular phone devices in the communication network via cellular communications, WiFi or radio.

'681 patent, 5:14-24.

> The method, device and system include the ability of a specific user device to provide polling in which other cellular phone devices, using SMS, internet or WiFi, report periodically based on criteria such as time, speed, distance traveled, or a combination of time, speed and distance traveled. The user can manually poll any or all of the cell phone devices that are used by all of the participants in the communication network having the same devices. The receiving cellular phone device application code responds to the polling command with the receiving cellular phone device's location and status, which could include battery level, GPS status, signal strength and entered track data. Optionally, the cell phone device users can set their cell phone devices to report automatically, based on time or distance traveled intervals or another criterion.

'681 patent, 9:5-19. One of ordinary skill in the art would have understood that this embodiment utilized CPU software to exchange data with other participants. One of ordinary skill in the art would have understood that these algorithmic steps describe how to implement the exchange of data by using CPU software.

36. It is my opinion that one of ordinary skill in the art would have been able to implement the disclosed algorithm using known modules of networking and user interface code.

6. "private … network"

AGIS's Proposed Construction	"a network where access is limited"
Life360's Proposed Construction	"a network where access is limited to those having a password and/or a particular phone number"
Claims	'954 patent, claim 1

37. I understand that "private . . . network" appears in only one asserted claim: claim 1 of the '954 patent.

38. I understand that AGIS and Life360 have agreed to construe "public . . . network" as "a network which anyone can access." As I described above, I have reviewed the '954 patent as well as its prosecution history. It is my opinion that one of ordinary skill in the art would

understand that a "private . . . network" in the context of the '954 patent is "a network where access is limited."

39. One of ordinary skill in the art would have understood that networks, such as the claimed networks, would allow for varying degrees of public and private disclosure of information. Furthermore, one of ordinary skill in the art would have understood that a "private . . . network" is one where access is limited in some way, and would not have understood access to be limited in any particular way. Known limitations on access would have included password protection, as well as other authentication methods such as secure keys, tokens, or identifiers.

40. The specification of the '954 patent describes authenticating with passwords, as well as with a user identifier such as the user's phone number. *See, e.g.,* '954 patent, 10:1-8; Fig. 3C. One of ordinary skill in the art would have understood that the user's phone number could have been replaced by other identifiers, such as the user's IP address or any other user identifier. In addition, one of ordinary skill in the art would have known that a password could have been replaced by other authentication credentials such as a security question or token.

7. "peer to peer network"

AGIS's Proposed Construction	"a network in which client devices exchange information with each other"
Life360's Proposed Construction	"a network in which devices exchange information directly without using a server"
Claims	'954 patent, claim 1

41. I understand that the claim term "peer to peer network" appears in only one asserted claim (claim 1) of the '954 Patent.

42. I note that the term "peer to peer network" was widely used in the art at the time of the filing of the '954 patent, but was used to refer to several different network architectures. As described in a published survey of the field, "the Schollmeier reference"[1],

> A basic problem we often encountered, is the multi-faceted and confusing situation, concerning the terms related to Peer-to-Peer networking in publications and discussions. Often *Peer-to-Peer* is used without having clearly stated the meaning of *Peer-to-Peer*. Thus it may happen, that sometimes in discussions the term *Peer-to-Peer* is used with completely opposing meanings.

(Schollmeier, p. 1)

The Schollmeier reference goes on to say that "the most distinctive difference between *Client/Server* networking and *Peer-to-Peer* networking" is the "the capability of the nodes of a *Peer-to-Peer* network of acting at the same time as server as well as a client." (Schollmeier, p. 1.) I agree with this assessment, namely, that unlike a client/server network where there is a server providing resources (e.g. data and/or storage) and clients consuming the resources, in a peer to peer network, the nodes both provide and consume resources.

43. The Schollmeier reference discusses two different models of peer to peer networks found in the art, a "pure" peer to peer network in which no central entity (*e.g.*, a server) is used and a "hybrid" peer to peer network in which a central entity is used. (Schollmeier p. 2.) I agree with this taxonomy, and I note that both models of peer to peer networks are consistent with AGIS's proposed construction of a peer to peer network as "a network in which client devices exchange information with each other". Since Life360's proposed construction adds the restriction that the devices must exchange information "directly without using a server", only the "pure" peer to peer network model would be consistent with Life360's proposed construction.

[1] "A Definition of Peer-to-Peer Networking for the Classification of Peer-to-Peer Architectures and Applications" by R. Schollmeier. *Proceedings of the First IEEE International Conference on Peer-to-Peer Computing* (P2P'01), 2002. (Attached as Exhibit 2.)

44. It is worth noting that two peer to peer systems widely used prior to the filing of the '954 patent, Napster[2] and Skype[3], utilized servers for at least some portion of their network architecture.

45. Thus, in my opinion, the only way to determine what the patentee of the '954 patent meant by "peer to peer network", as recited in claim 1, is to consider the *intrinsic* evidence, namely how the term was used in the patent specification, claims and the file history.

46. As a preliminary matter, the patent specification discloses a "peer to peer server" in several places (for example, '954 patent, Figs. 2C, 3; Col. 10. l. 9), and thus clearly contemplates the possibility of a server within a peer to peer network. Figure 3 of the '954 patent makes it clear that the "peer to peer server" is a central entity, consistent with the "hybrid" peer to peer model.

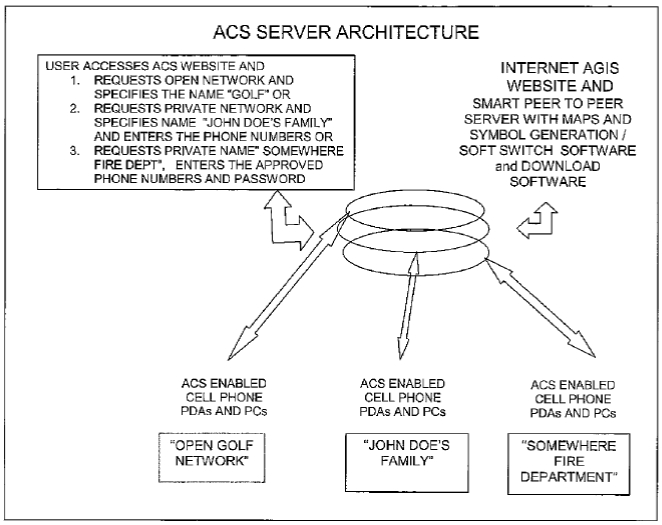


Fig 3

[2] For example, Napster's legal problems stemmed from the use of its servers in its peer to peer network as described in *A&M Records, Inc. v. Napster, Inc.*, 239 F.3d 1004 (9th Cir. 2001).

[3] "An Analysis of the Skype Peer-to-Peer Internet Telephony Protocol," Baset, S.A., Schulzrinne, H., Department of Computer Science Columbia University, New York NY 10027, September 15, 2004 (available at http://arxiv.org/pdf/cs/0412017v1.pdf) (describing Skype)

47. Additionally, in determining the meaning of the term "peer to peer network," one of ordinary skill in the art would have looked to the specific language of the claim. The entire limitation is as follows:

> "accessing with a remote network server from a system website for the purpose of establishing either public or private networks that can then enable those who have accessed the website the ability to define public and private peer to peer, networks each with its own symbols and soft switches"

('954 Patent claim 1)

48. I note that this limitation requires two networks: a first private or public network that is not required to be peer to peer, and a second private or public "peer to peer network" with its own symbols and soft switches. The specification provides an example of a non-peer to peer network, in which a server gathers location information from each participant and provides the location information to all the participants (via, for example, a broadcast):

> Network participant location, identity and status messages are sent to the server by each client. Network participant entered tracks are also sent to the server. Because this data is of interest to all the network participants, the server forwards the data received from one participant to all other participants, thus providing the information necessary for all network participants to know the identity, location and status of all other network participants.

('954 Patent at Col. 2, ll. 50-57.) That is, the server is acting as a centralized clearinghouse for location data of all participants, which is representative of the kind of function that a server in a client/server architecture would provide.

49. The '954 patent specification (in the portion immediately following the above description) also describes the use of the server as simply forwarding data between participants, supporting the participants' ability to exchange information, such as text, messages, photos, etc:

> The server also acts as a forwarder of data addressed from one participant to one or more addressed participants, thus permitting the transmission of free text, preformatted messages, photographs, video E mail and URL data from one network participant to other selected network participants.

('954 Patent at Col. 2, ll. 58-62.) This function of the server, namely, simply forwarding data so that participants can exchange information, is consistent with the peer to peer network as described in claim 1 (and with the "hybrid" peer to peer network model described in the Schollmeier reference). In this case, the data is specifically *addressed* from one participant to one or more participants—as one finds in a peer to peer network—rather than using the server as a central data clearinghouse. For the peer to peer network of the claimed invention, the patentee stated that a centralized static IP routable server was used to attain the level of security that cell phone companies require. Additionally, generally speaking, carriers and internet service providers limited the number and types of ports available that were open for communication.

50. Thus, because of the clear intrinsic evidence regarding the patentee's intended meaning of "peer to peer networks", I agree with AGIS's proposed construction, namely "a network in which client devices exchange information with each other", but I disagree with the additional restrictions proposed by Life360, namely that the information must be exchanged "directly without using a server".

8. "SMS polling message"

AGIS's Proposed Construction	"a Short Message Service message sent from one device to another that commands a response from the recipient device"
Life360's Proposed Construction	"a Short Message Service message sent from one device to another that commands a response from the recipient device" The SMS polling message cannot be an IP message.
Claims	'441 patent, claim 1

51. I understand that the claim term "SMS polling message" appears in only one asserted claim: claim 1 of the '441 Patent. As an initial matter, I note that the term "SMS" has a

specific meaning to one of ordinary skill in the art that is consistent with the specification of the '441 patent, in other words, "Short Message Service."

52. The only difference between AGIS's proposed construction and Life360's construction is that Life360's construction excludes IP messages. One of ordinary skill in the art would have understood that SMS messages may actually be sent using the Internet Protocol ("IP"). For example, the organization responsible for developing the 3G cellular standard, the 3rd Generation Partnership Project ("3GPP"), contemplated, at least as early as 2006, allowing SMS messages to be communicated using IP, and included IP support for SMS since late 2007:

5 Specifications and Reports

NOTE 1: The "for publication?" column of the table below indicates whether or not the documents are intended for adoption by the partner Standards Development Organizations as their own publications. Those marked "no" are internal working documents of the 3GPP TSGs.

NOTE 2: Some of the algorithm specifications in the 35.-series are available only under licence.

NOTE 3: "Type" indicates Technical Specification (TS) or Technical Report (TR).

NOTE 4: For definition of "freezing" of specifications (last two columns), see 3GPP TS 21.900 [2].

Type	Number	Title	WG prime	For publication?	freeze date	frozen
		* * *				
TS	24.341	Support of SMS over IP networks; Stage 3	C1	Yes	2007-06-07	yes

(3GPP TS 21.101 V7.0.0 (2007-09))[4]

53. Accordingly, one of ordinary skill in the art would have known that SMS messages could be sent using IP. Therefore, I disagree with Life360's proposed construction.

[4] SMS over IP was discussed in drafts as early as May 20006, e.g., 3GPP TS 24.341 V0.0.3 (2006-05) (available at http://www.3gpp.org/dynareport/24341.htm)

9. "establishing, over a private remote server excluding a website or a web browser, a communications network"

AGIS's Proposed Construction	"establishing a communications network over a private remote server and not through a website or web browser"
Life360's Proposed Construction	Indefinite and not amenable to construction. Alternative: "establishing a communications network over a private remote server that is not accessible by a web browser or through a website"
Claims	'441 patent, claims 1, 4

54. I understand that the claim term "establishing, over a private remote server excluding a website or a web browser, a communications network" appears in asserted claims 1 and 4 of the '441 patent, which are both method claims. As a preliminary matter, one of ordinary skill in the art would have understood the terms "website" and "web browser" based on their ordinary meaning. One of ordinary skill in the art would have understood a website to be an Internet-based resource on a web server that is accessible by a web browser using the HTTP protocol. Further, one of ordinary skill in the art would have understood a web browser to be a piece of software that can interface with that web server. Additionally, one of ordinary skill in the art would have understood that there were many other Internet-based resources accessible via IP communications by remote devices that did not include websites and that were not accessible only with web browsers. For example, the Internet allowed for other communications protocols, such as Telnet, SSH, FTP and other proprietary packet-based IP communications, none of which required a website or web browser.

55. I note that Life360's proposed construction, "establishing a communications network over a private remote server that is not accessible by a web browser or through a website", is ambiguous. It is unclear whether the term "that is accessible by a web browser or

through a website" applies to the communications network after it has been established or whether it applies to the private remote server that is used to establish the network. I address both possibilities below, but find that this ambiguity is sufficient to reject Life360's construction.

56. In the case that Life360 is proposing that the private remote server must not be accessible by a web browser or through a web site, I disagree with that construction. Being a part of a method claim, the claimed limitation restricts the method of establishing the network, (*i.e.* the claimed method does not use a browser or web site to establish the network), and does not prescribe limitations on the apparatus that is used. In this case particularly, one of skill in the art would have understood that the limitation does not address the capabilities of the remote server, because servers do not utilize "web browsers" (clients do), but rather specifying how a user may interact with the remote server to establish the network. In the claimed method, as long as the user does not use a browser to interact with a web site to establish the claimed network, it is irrelevant what other capabilities the server may have. Further, as described below, the patentee distinguished the claimed invention from the Crowley reference by pointing out that, in Crowley, a web site is required to establish the network, while in the claimed invention, no such web site is required. Thus, in my opinion, as long as the network is established using a private remote server and without using a browser or web server, the claimed limitation would be met.

57. As I described above, the specification of the '441 patent describes establishing a communications network so that groups of people can view each others' locations and communicate. One of ordinary skill in the art would have understood that this limitation is only concerned with the method step of establishing, (*i.e.*, setting up the network), and not with access to the network afterwards. Accordingly, the only reasonable meaning of this claim term is that the step of establishing the network can not be carried out via a website or a web browser, but

must be carried out by some other means, such as through another protocol for IP communications with a server. Whether the network is accessible via a website or a web browser after establishing the network is irrelevant, and one of ordinary skill in the art would not have expected that the "private remote server" "is not accessible by a web browser or through a website" as Life360 contends. One of ordinary skill in the art would have understood that there were countless purposes for which one might want to access the remote server through a website or web browser other than for establishing the communications network.

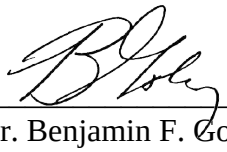
58. Upon review of the specification and prosecution history of the '441 patent, I have confirmed that both are consistent with AGIS's construction, and both are inconsistent with Life360's construction. For example, the '441 patent explains that the remote "server acts as a *forwarder* for IP communications *between any combination of cell phone/PDA users and/or PC based users*." '441 patent, 2:9-11 (emphasis added); *see also, e.g., id.* at 2:11-18, 3:15-29. The '441 patent explains that the communications network is established directly over a private remote server and, thus, not through a website or web browser. *See, e.g., id.* at 2:9-32, 3:15-29. During prosecution, in a Response and Amendment dated October 7, 2011, the applicant explained that the claimed method was different from U.S. Patent No. 7,593,740 ("Crowley") because Crowley's network was established by "entry of phone numbers or e-mail addresses *into the web site* to enable the web server to establish the networks between individuals"—the applicant's invention did not require entry of data into a web-site via a web browser. '441 patent File History, Response and Amendment dated 2/23/2011, p. 10 (emphasis added). Accordingly, it is my opinion that the claim limitation when read in light of the specification and prosecution history is consistent with AGIS's construction and inconsistent with Life360's construction.

VIII. Reservation of Rights

59. I reserve the right to supplement or amend my opinions in response to opinions expressed by Defendant's experts, or in light of any additional evidence, testimony, discovery, or other information that may be provided to me after the date of this declaration. In addition, I reserve the right to consider, and testify about, issues that may be raised by Defendant's fact witnesses and experts at any hearing or in any expert reports. I also reserve the right to modify or to supplement my opinions as a result of ongoing fact and expert discovery or testimony at trial.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on September 17, 2014



Dr. Benjamin F. Goldberg

EXHIBIT 1

Curriculum Vitae

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Personal

Born January 31, 1961, Las Cruces, New Mexico.

U.S. Citizen.

Education

Ph.D. in Computer Science, Yale University, 1988. Dissertation: "Multiprocessor Execution of Functional Programs."

M.S. and M.Phil in Computer Science, Yale University, 1984.

B.A. with Highest Honors in Mathematical Sciences, Williams College, Cum Laude, Phi Beta Kappa, Sigma Xi, June 1982. Honors Thesis: "Theory and Implementation of an Automatic Program Verifier."

Employment

Associate Professor (Tenured), Courant Institute of Mathematical Sciences, Department of Computer Science, New York University. September 1994 – Present.

Invited Professor, Ecole Normale Supérieur, Paris, France. June 2007 – July 2007 and June 2003 – July 2003.

Director of Graduate Studies (for the MS programs), Department of Computer Science, New York University. September 2009 – August 2012 and September 2014 – present.

Director of Undergraduate Studies, Department of Computer Science, New York University. September 1995 – August 1998 and September 2003 – August 2006.

Visiting Professor, Institute National de Recherche en Informatique et en Automatique (INRIA), Rocquencourt, France. September 1994 – August 1995.

Assistant Professor, Courant Institute of Mathematical Sciences, Department of Computer Science, New York University. September 1987 - August 1994.

Expert Testimony at Trial or Deposition in the Past Five Years

Retained by Milbank Tweed on behalf of Apple in the matter of *Wi-LAN v. Apple*, February 2014 – present.

Retained by Boies Schiller on behalf of Apple in the matter of *Apple v. Personal Web Communications* (*Inter Partes Review* before the PTO), August 2013 – present.

Retained by Cooley on behalf of Apple in the matter of *GBT v. Apple,* October 2013 – June 2014.

Retained by Quinn Emanuel on behalf of Toshiba in the matter of *Certain Digital Media Devices, Including Televisions, Blu-Ray Disc Players, Home Theater Systems, Tablets and Mobile Phones, Components Thereof and Associated Software* (Black Hills Media v. Toshiba et al). International Trade Commission. September 2013 – February 2014.

Retained by Wilson Sonsini on behalf of Sasken in the matter of S*asken v. Spreadtrum*. American Arbitration Association. July 2013 – January 2014.

Retained by Sheppard Mullin on behalf of HTC and Apple in the matter of *Wi-LAN v. HTC et al*. June 2013 – October 2013.

Retained by Bingham McCutchen on behalf of Oracle America in the matter of *Oracle America v. Service Key et al.* March 2013 – September 2013.

Retained by Latham & Watkins on behalf of InterDigital Communications, Inc. in the matter of *Certain Wireless Devices with 3G Capabilities and Components Thereof* (InterDigital v. Huawei et al). International Trade Commission, December 2011 – February 2013.

Retained by Ballard Spahr on behalf of Go Daddy in the matter of *WhitServe v. Go Daddy.* August 2011 – June 2013.

Retained by Kenyon & Kenyon on behalf of Barnes & Noble in the matter of *Deep9 v. Barnes & Noble*. February 2012 – August 2012.

Retained by Gibson Dunn & Crutcher on behalf of Lawson Software in the matter of *ePlus v Lawson Software*. October 2011 – April 2013.

Retained by Kenyon & Kenyon on behalf of Barnes & Noble in the matter of *Certain Handheld Electronic Computing Devices, Related Software, and Components Thereof* (Microsoft v. Barnes & Noble), International Trade Commission. August 2011 – February 2012.

Retained by Morrison & Foerster on behalf of Oracle America in the matter of *Oracle America v. Google*. August 2011 – May 2012.

Retained by Jones Day on behalf of Nielsen in the matter of *comScore v. Nielsen et al*. May 2011 – November 2011.

Retained by Kellogg Huber on behalf of Verizon in the matter of *ActiveVideo Networks v. Verizon Communications*. February 2011 – July 2011.

Retained by Marino, Tortorella & Boyle on behalf of Sergey Aleynikov in the matter of *United States v. Sergey Aleynikov*. May 2010 – December 2010.

Retained by Weil Gotshal & Manges on behalf of Aruba Networks in the matter of *Commil USA v. Aruba Networks*. December 2009 – May 2010.

Retained by Finnegan & Henderson on behalf of Toyota in the matter of *Gardner v. Toyota*. September 2009 – March 2010.

Retained by Hinkle Hensley on behalf of Morco Geological Services in the matter of *Morco Geological Services v. Randall M. Amen*. November 2009 – March 2010.

Retained by Sheppard Mullin on behalf of PCD in the matters of *Wi-LAN v. Acer et al*. November 2009 – January 2011.

Retained by Hughes Hubbard & Reed on behalf of SyncSort in the matter of *SyncSort v. IRI*. September 2005 – March 2011.

Retained by Kenyon & Kenyon on behalf of Cooper Neff and BNP Paribas in the matter of Steven A. Zimmer v. Cooper Neff Advisors, Inc. and BNP Paribas SA. September 2004 – May 2010.

Teaching Awards

New York University "Golden Dozen" Award, 1992. Awarded to twelve faculty members in the entire College of Arts and Sciences for excellence in teaching.

Professional Activities

Editorial Board, *The Computer Journal*. Published by Oxford University Press on behalf of the British Computer Society. 2007 – 2009.

Program Committee member: 2007 Symposium on Principles of Programming Languages (POPL)

External Review Committee member: 2013 Symposium on Principles of Programming Languages (POPL)

Program Committee member: 2001 Workshop on Practical Applications of Declarative Languages (PADL'01), ACM SIGPLAN'95 Conference on Programming Language Design and Implementation, 1995 ACM SIGPLAN Symposium on Partial Evaluation and Semantics-Based Program Manipulation (PEPM '95), 1995 International Workshop on Memory Management (IWMM'95), ACM SIGPLAN'93 Conference on Programming Language Design and Implementation.

Review Panel Member, National Science Foundation, January 1998 and January 2000.

Official Collaborator, Los Alamos National Laboratory, Computing and Communications Division.

Member, Association for Computing Machinery and ACM Special Interest Group on Programming Languages (SIGPLAN).

Referee for: ACM TOPLAS, IEEE Computer, International Journal of Parallel Programming, Software Practice and Experience, Computational Intelligence, ACM TOCS, ACM Computing Surveys, etc.

Referee for a variety of ACM and IEEE conferences.

Journal Papers

"Translation and Run Time Validation of Optimized Code", with L. Zuck, A. Pnueli, C. Barrett, Y. Fang, and Y. Hu, *Formal Methods in System Design*. 27(3): 335-360, November 2005

"VOC: A Methodology for Translation Validaton of Optimizing Compilers", with L. Zuck, A. Pnueli, and Y. Fang. *Journal of Universal Computer Science*, March 2003.

"A Syntactic Method for Finding Least Fixed Points of Higher-Order Functions over Finite Domains", with Tyng-Ruey Chuang. *Journal of Functional Programming*. Vol. 7, No. 4, pp. 357-394, July 1997

"Functional Programming Languages", in ACM 50th Anniversary Issue of Computing Surveys. March 1996.

"Order-of-demand analysis for lazy languages", with Young-Gil Park. Information Processing Letters, Vol. 55, 1995, pp. 343-348.

"Static Analysis for Optimizing Reference Counting", with Young-Gil Park. Information Processing Letters, Vol. 55, 1995, pp. 229-234.

"Multiprocessor Execution of Functional Programs", International Journal of Parallel Programming, Vol. 17, No. 5, October 1988.

"Distributed Execution of Functional Programs Using Serial Combinators," with P. Hudak, IEEE Transactions on Computers, Vol. C-34, No. 10, October 1985, pp. 881-891.

Books or Chapters in Books

"Functional Programming Languages", in Handbook of Computer Science and Engineering, CRC Press, Inc. 1996.

Publications in Proceedings of Refereed Symposia

“Translation Validation of Loop Optimizations and Software Pipelining in the TVOC Framework”. Proceedings of the 17th International Static Analysis Symposium (SAS 2010), September 2010.

“TVOC: A translation validator for optimizing compilers”, with C. Barrett, Y. Fang, Y. Hu, A.Pnueli, and L. Zuck. Proceedings of the 17th International Conference on Computer Aided Verification (CAV '05), July 2005.

"Theory and algorithms for the generation and validation of speculative loop optimizations", with Y. Hu and C. Barrett. Proceedings of the 2nd IEEE International Conference on Software Engineering and Formal Methods (SEFM), September 2004.

"Into the Loops: Practical Issues in Translation Validation for Optimizing Compilers", with L. Zuck and C. Barrett. Proceedings of the Third International Workshop on Compiler Optimization meets Compiler Verification (COCV). April 2004.

"Run-Time Validation of Speculative Optimizations using CVC", with C. Barrett and L. Zuck. Proceedings of the Workshop on Runtime Verification 2003, ENTCS 89(2). July 2003.

"Software Bubbles: Using Predication to Compensate for Aliasing in Software Pipelines", with E. Chapman, C. Huneycutt, and K. Palem. Proceedings of the PACT-2002 International Conference on Parallel Architectures and Compilation Techniques, September 2002.

"Translation and Run-Time Validation of Optimized code", with L. Zuck, A. Pnueli, Y. Fang, and Y. Hu. Proceedings of the Workshop on Runtime Verification 2002, ENTCS 70(4). July 2002.

"VOC: A Translation Validator for Optimizing Compilers". Proceedings of the Workshop on Compiler Optimization Meets Compiler Verification (COCV) 2002, ENTCS 65(2). April 2002.

"Formal Models of Distributed Memory Management", with Cristian Ungureanu. Proceedings of the ACM International Conference on Functional Programming, June 1997.

"Partial Evaluation of Concurrent Programs", with Mihnea Marinescu. Proceedings of the ACM Symposium on Partial Evaluation and Program Manipulation, June 1997.

"Real-Time Deques, Multihead Turing Machines, and Purely Functional Programming", with T-R. Chuang. Proceedings of the 1993 ACM Conference on Functional Programming Languages and Computer Architecture, June 1993.

"Polymorphic Type Reconstruction for Garbage Collection without Tags", with M. Gloger. Proceedings of the 1992 ACM Conference on LISP and Functional Programming, June 1992.

"A Syntactic Approach to Fixed Point Computation on Finite Domains", with T.R. Chuang. Proceedings of the 1992 ACM Conference on LISP and Functional Programming, June 1992.

"Escape Analysis on Lists", with Y.G. Park. Proceedings of the 1992 ACM SIGPLAN Conference on Programming Language Design and Implementation, June 1992.

"Incremental Garbage Collection without Tags", Proceedings of the 1992 European Symposium on Programming, February 1992.

"Reference Escape Analysis: Optimizing Reference Counting based on the Lifetime of References", with Y.G. Park. Proceedings of the 1991 ACM/IFIP Conference on Partial Evaluation and Program Manipulation, June 1991.

"Tag-Free Garbage Collection for Strongly Typed Programming Languages", Proceedings of the ACM SIGPLAN'91 Conference on Programming Language Design and Implementation, June 1991.

"Higher Order Escape Analysis: Optimizing Stack Allocation in Functional Program Implementations", Proceedings of the 1990 European Symposium on Programming, May 1990. Springer-Verlag LNCS 432, pp. 152-160.

"Generational Reference Counting: A Reduced-Communication Distributed Storage Reclamation Scheme", Proceedings of the SIGPLAN'89 Conference on Programming Language Design and Implementation, June 1989.

“A Reduced-Communication Storage Reclamation Scheme for Distributed Memory Multiprocessors", Proceedings of the Fourth Conference on Hypercubes, Concurrent Computers, and Applications, January 1989.

"Buckwheat: Graph Reduction on a Shared Memory Multiprocessor", Proceedings of the 1988 ACM Symposium on Lisp and Functional Programming, July 1988, pp. 40-51.

"Executing Functional Programs on a Hypercube Multiprocessor", Proceedings of the Third Conference on Hypercube Concurrent Computers and Applications, January 1988.

"Detecting Sharing of Partial Applications in Functional Programs", Proceedings of the Conference on Functional Programming Languages and Computer Architecture, September 1987. Published in the Springer-Verlag Lecture Notes in Computer Science, Vol. 274, pp. 408-425.

"Serial Combinators: "Optimal" Grains of Parallelism", with P. Hudak, Proceedings of the IFIP Conference on Functional Programming Languages and Computer Architecture, September 1985. Published in the Springer-Verlag Lecture Notes in Computer Science, Vol. 201, pp. 382-389.

"Experiments in Diffused Combinator Reduction," with P. Hudak, Proceedings of the ACM Symposium on Lisp and Functional Programming, August 1984, pp. 167-176.

Keynote Addresses, Invited Talks and Tutorials

Keynote Address, "Software Pipelining and Loop Optimizations in the Presence of Memory Aliasing", 8th Workshop on Compiler Techniques for High Performance Computing, Hualien, Taiwan, March 2002.

Invited Talk, "Translation Validation of Loop Optimizations", Ecole Normale Supérieur, Paris. July 2003.

Invited tutorial, "The Trimaran Compiler Research Infrastructure", given at at the following conferences:

- IEEE Symposium on Parallel Architectures and Compiler Techniques (PACT'98), Paris, October 1998.
- IEEE Symposium on Microarchitecture (MICRO-31), Dallas, December 1998.
- 1999 ACM SIGPLAN Conference on Programming Language Design and Implementation (PLDI'99), Atlanta, June 1999.

Tutorial, "Functional Programming", 1994 ACM SIGPLAN Conference on Programming Language Design and Implementation (PLDI'94). Orlando, June 1994.

Research Grants and Contracts

“Property-Based Development of reactive and Embedded Systems”, with A. Pnueli and L. Zuck. National Science Foundation, August 2007 – May 2009.

“PTV: Translation Validation in the Phoenix Compiler Framework”, with A. Pnueli (coordinated proposal with L. Zuck of U. Illinois-Chicago). Microsoft, April 2006.

"A Methodology for Establishing the Dependability and Security of Telecommunication Protocols", with A. Pnueli and L. Zuck. Office of Naval Research, July 2003 – June 2005.

"Towards a Seamless Process for the Development of Embedded Systems", with A. Pnueli and L. Zuck. National Science Foundation, September 2002 - August 2005.

"Translation Validation of Advanced Compiler Optimizations", with L. Zuck and A. Pnueli. National Science Foundation, June 2001 – May 2006.

"Algorithmic Techniques for Compiler Controlled Caches", with K. Palem. Air Force, July 1999 - June 2002.

"Parallel Extensions of the MSTAR System", with E. Freudenthal. AFOSR, August 1999 - July, 2001.

"A Computational Laboratory for Automatic Target Recognition", with D. Geiger and E. Freudenthal. AFOSR, March 1998 - March 1999.

"Mobile and Stationary Target Acquisition and Recognition", DARPA/Air Force, June 1997-March 2000.

"An Integrated Parallel Programming Environment for High Performance Parallel Computing on Workstation Clusters", Department of Energy. May 1994. With Los Alamos National Laboratory and IBM.

"GRIFFIN - A Common Prototyping Language: Design, Implementation, and Assessment", with R. Dewar, M. Harrison, E. Schonberg and D. Shasha. DARPA/Office of Naval Research, May 1992 - April 1995.

"Research Training in Software Prototyping Languages and Environments". DARPA/ONR May 1992 - April 1995.

"Studies in Automatic Dynamic Load Balancing on Large Loosely-Coupled Multiprocessors", National Science Foundation Research Initiation Award. September 1989 - June 1992.

"GRIFFIN: a Common Prototyping Language", with R.Dewar, E. Schonberg, M. Harrison, and D. Shasha. DARPA/ONR September 1989 - April 1992.

New Courses Developed

“Object Oriented Programming”. An undergraduate course covering Java, C++, UML, and object oriented programming techniques. Also developed an MS-level OOP course.

"The Design and Programming of Embedded Systems". A graduate course addressing the computing hardware and software designs in handheld devices, cell phones, appliances, etc.

"Compilers for Advanced Computer Architectures". A graduate course in optimization techniques for emerging microprocessors.

"Honors Programming Languages". A Ph.D. course in Programming Language Design and theory.

EXHIBIT 2

A Definition of *Peer-to-Peer* Networking for the Classification of *Peer-to-Peer* Architectures and Applications

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Abstract

The main contribution of the poster, which is shortly outlined in the following, is to offer a definition for Peer-to-Peer networking and to make the differences to common so called Client/Server-architectures clear. With this definition we are able to classify currently existing networking concepts in the Internet either as "Pure" Peer-to-Peer, or "Hybrid" Peer-to-Peer or Client/Server architecture.

1 Introduction

Peer-to-Peer Networking is mostly known under the brand of Napster. Within this application the Peer-to-Peer networking concept is used to share files, i.e. the exchange of MPEG Layer3 (mp3) compressed audio files. However, Peer-to-Peer is not only about file sharing, it is also about establishing multimedia communication networks based on Peer-to-Peer concepts or resource sharing.

A basic problem we often encountered, is the multifaceted and confusing situation, concerning the terms related to Peer-to-Peer networking in publications and discussions. Often *Peer-to-Peer* is used without having clearly stated the meaning of *Peer-to-Peer*. Thus it may happen, that sometimes in discussions the term *Peer-to-Peer* is used with completely opposing meanings.

The central theme of this poster therefore is to bring in a clear definition of *Peer-to-Peer* networking and its different facets, like e.g. *"Hybrid" Peer-to-Peer* networking. Further on we also give a definition of the classical *Client/Server* architectural concept, to make a distinctive delimitation to *Peer-to-Peer* network architectures possible.

2 Definition of *Peer-to-Peer* and *Client/Server* networking

Peer-to-Peer networking is not new. Already a few years ago the advantages of *Peer-to-Peer* networking have been recognized and thus investigations into these architectures were made [You93] [Sim91]. Others like e.g. [Met01] and [Wra94] define *Peer-to-Peer* networks just as a collection of heterogeneous distributed resources which are connected by a network. Some attempts to describe *Peer-to-Peer* networks more extensively, than in just an application specific way, define *Peer-to-Peer* simply as the opposite of *Client/Server* architectures [Sin01] [Tho98].

However, from our point of view, the most distinctive difference between *Client/Server* networking and *Peer-to-Peer* networking is the concept of an entity acting as a *Servent*, which is used in *Peer-to-Peer* networks. *Servent* is an artificial word which is derived from the first syllable of the term server ("Serv-") and the second syllable of the term client ("-ent"). Thus this term *Servent* shall represent the capability of the nodes of a *Peer-to-Peer* network of acting at the same time as server as well as a client. This is completely different to *Client/Server* networks, within which the participating nodes can either act as a Server or act as a client but cannot embrace both capabilities.

The above shortly outlined features of *Peer-to-Peer* networks can be concluded in Definition 1. Service in this conext is understood as outlined in [Kel98].

> *A distributed network architecture may be called a Peer-to-Peer (P-to-P, P2P,...) network, if the participants share a part of their own hardware resources (processing power, storage capacity, network link capacity, printers,...). These shared resources are necessary to provide the Service and content offered by the network (e.g. file sharing or shared workspaces for collaboration). They are accessible by other peers directly, without passing intermediary entities. The participants of such a network are thus resource (Service and content) providers as well as resource (Service and content) requestors (Servent-concept).*

Definition 1 The definition of *Peer-to-Peer*

To be able to distinguish *Peer-to-Peer* networks with a central entity from those without any central entities, it is general practice to split the *Peer-to-Peer* networking definition into two sub-definitions. They are generally known as the *"Hybrid" Peer-to-Peer* networking con-

Proceedings of the First International Conference on Peer-to-Peer Computing (P2P'01)
0-7695-1503-7/02 $17.00 © 2002 IEEE

cept, which allows the existence of central entities in its network, and the *"Pure" Peer-to-Peer* networking concepts within which *Servents* are the only entities allowed. These two concepts are defined in the following way:

> *A distributed network architecture has to be classified as a "Pure" Peer-to-Peer network, if it is firstly a Peer-to-Peer network according to Definition 1 and secondly if any single, arbitrary chosen Terminal Entity can be removed from the network without having the network suffering any loss of network service.*

Definition 2 The definition of *"Pure" Peer-to-Peer*

The key distinction of *"Hybrid" Peer-to-Peer* compared to *"Pure" Peer-to-Peer* is the fact, that a *"Hybrid" Peer-to-Peer* network always includes a central entity, which is "forbidden" by definition in *"Pure" Peer-to-Peer* networks. On the other hand *"Hybrid" Peer-to-Peer* networks differ from *Client/Server* networks, because the feature of the nodes to share resources is substantial in *"Hybrid" Peer-to-Peer* networks.

> *A distributed network architecture has to be classified as a "Hybrid" Peer-to-Peer network, if it is firstly a Peer-to-Peer network according to Definition 1 and secondly a central entity is necessary to provide parts of the offered network services.*

Definition 3 The definition of *"Hybrid" Peer-to-Peer*

One significant difference of *Client/Server* networking compared to *Peer-to-Peer* networking is that the clients do not share any of their resources (storage capacity, computing power, network connection, bandwidth, content). In the *Client/Server* concept exists only one central entity, which provides all the content and services which are offered in a certain network.

> *A Client/Server network is a distributed network which consists of one higher performance system, the Server, and several mostly lower performance systems, the Clients. The Server is the central registering unit as well as the only provider of content and service. A Client only requests content or the execution of services, without sharing any of its own resources.*

Definition 4 The definition of *Client/Server*

3 Conclusion

The introduction of a profound and clear definition of the understanding of *Peer-to-Peer* -networking is a first step to understand and be able to estimate the impacts of this new arising networking technology. We feel the need for such a basic work, because the main problem of today's discussions and publications in the field of *Peer-to-Peer* networking are, the different and often even opposing understandings of *Peer-to-peer* networking. Meaningful discussions were hardly possible until now, because of the vagueness about the terms used in *Peer-to-Peer* networking.

Nevertheless there is still a long way to go, until *Peer-to-peer* networking is going to become a real success story. A lot of problems still have to be solved and one of them is certainly the traffic engineering problem encountered especially in completely flat routing architectures. New, dynamic routing concepts have to be developed, as for example dynamic hierarchical routing topologies we envision as a solution for today's encountered traffic problems. Although there are still a of problems to be solved, this might finally lead to a *Peer-to-Peer* based third generation Internet.

4 References

[Kel98] W. Kellerer, „Dienstarchitekturen in der Telekommunikation – Evolution, Methoden und Vergleich". Technical Report TUM-LKN-TR-9801. 1998

[Met01] Meta Computing. "Peer-to-Peer Architecture Proposal Legion – An Integrated Architecture for Secure Resource Sharing". White paper. January 2001

[Sim91] S. Simon. "Peer-to-Peer Network Management in an IB; SNA Network" IEEE Network Magazine, pp. 30-34. March 1991.

[Sin01] M. P. Singh. "Peering at Peer-to-Peer Computing". IEEE Internet Computing, Vol. 5, No. 1. January/February 2001

[Tho98] L. Thomas, S. Suchter, A. Rifkin." Developing Peer-to-Peer Applications on the Internet: the Distributed Editor, SimulEdit". Dr. Dobb's Journal #281, pp. 76-81, January 1998.

[Wra94] S. Wray; T. Glauert; A. Hopper." The Medusa applications environment". Multimedia Computing and Systems, 1994., Proceedings of the International Conference on , Page(s): 265 –273. 1994

[You93] K. Young. "Look no Server". Network. pp.21,22 and 26, March 1993